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ABSTRACT

Investigations and theories concerning interrelationships of motoric experiences, perceptual-motor skills, and learning are reviewed, with emphasis on early engramming of form and space concepts. Covered are studies on haptic perception of form, the matching of perceptual data and motor information, Kephart's perceptual-motor theory, and supporting data for this theory from phsiological investigations. Such supporting data includes research on the concept of motor engrams, defined in physiological terms as a structural change in the nervous system effected by an experience. For visually handicapped children, the concept of motoric engrams is seen as an essential learning modality for motor orientation and spatial perception. Four motor generalizations significant in the education of blind children are delineated: balance and posture, contact, locomotion, and receipt and propulsion. Concluded is the importance of establishing spatial orientation intrinsically through gross motor movements in early childhood (gross motor engramming as a learning modality for interacting with one's environment). All children are seen to need gross motoric engrams as foundations for spatial-perceptual development, with the blind urgently needing motoric environmental interaction as a readiness base for mobility. (KW)

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THE UNIVERSITY OF TEXAS AT AUSTIN

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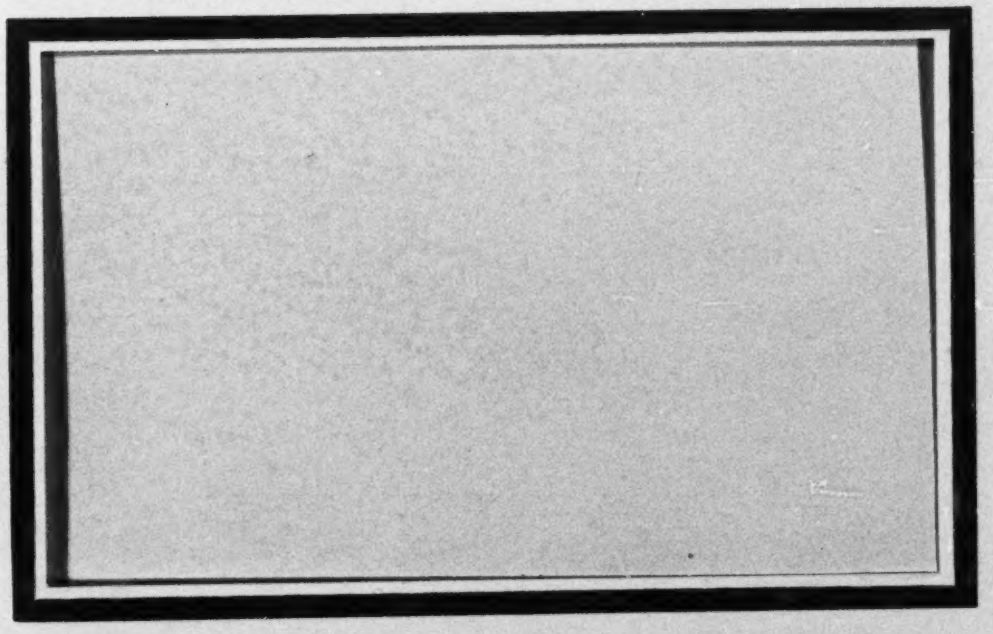

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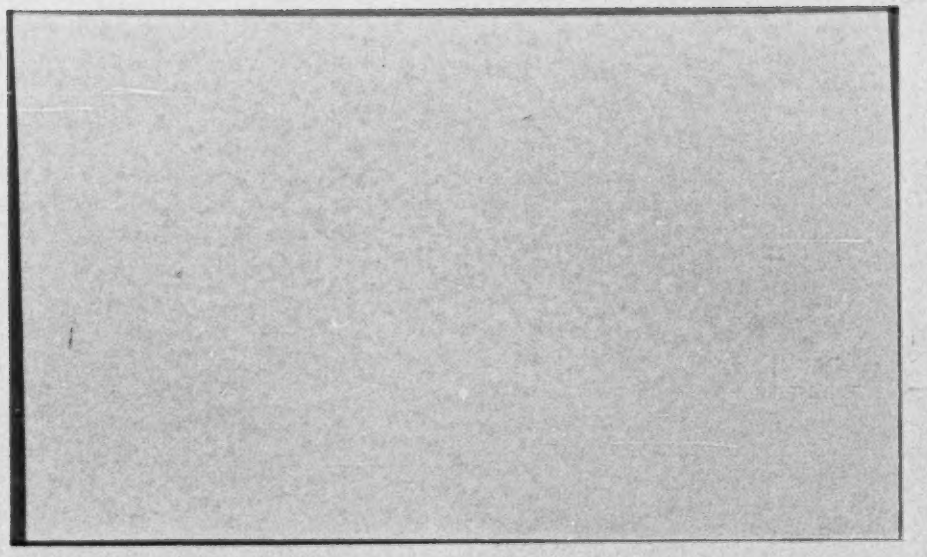

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GROSS MOTOR ENGRAMS: AN IMPORTANT SPATIAL LEARNING MODALITY

FOR

PRESCHOOL VISUALLY HANDICAPPED CHILDREN

by

Carol Whitcraft

Vol. I No. 9

Research Associate - Staff Training Project

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In reviewing behavioral research on the visually impaired, Nolan (1963) stressed the urgent need for future studies of haptic perception of form. He suggested that space perception as a function of auditory and haptic clues should be explored further in order to better understand and solve problems of mobility and spatial orientation.

Bateman (1967) listed one of three major educational needs for visually handicapped children as the teaching of mobility skills which enable the child to go to those sensory data which do not come to him. She cited the five year study of Norris, Spaulding and Brodie which found highest correlations between mobility and prognostic scales (.77) and between prognostic scales and opportunity for learning (.80).

Barraga (in press) emphasized the primary importance of the range and variety of concrete experiences in early life for the visually handicapped child and the continued use of concrete experiences and materials in all academic learning during the elementary years. Barraga acknowledges Gibson's view of the importance of motoric involvement of each body part with the object world for refining and discriminating perceptions and for receiving and interpreting environmental impressions.

Proper interpretation of environmental impressions is dependent on the emerging sense of separation of the body boundaries from the environment. The development of awareness of body parts, their interrelatedness and their connected separation from the environment begins in the active auto-tactual exploration of the body and the experiences of being handled with the attendant extrinsic kinesthetic and tactual sensations. Exploration of objects other than the body provides quite different sensations from those generated by handling of the body itself and sharpens the perception of differences between the "me" and "not-me" (Witkin, Dyk, Faterson, Goodenough and Karp, 1962).

Educators of blind children note that blind infants seem to have a vague idea about what is part of their bodies and what is not. Cratty (1968) observed that blind children have difficulty perceiving their bodies. On the basis of a study of relationship between movement attributes and body perceptions, Cratty (1968) found a high correlation between body-image scores and scores elicited from a comprehensive battery of perceptual-motor tasks. He concluded that body-image scores were more predictive of total battery score than any component of the evaluation instruments used. "Unless a child can identify his body parts it seems unlikely that he can move them very effectively" (Cratty, 1968).

Motoric involvement requires adjustments and skills of orientation and mobility for effective interaction of the blind person with his total environment through the processes of sensory perception, cognitive mapping and locomotion (Lord, 1967). The prerequisite to the development of these motor strategies directed at the outside world is the establishment of spatial relationships among the different mobile parts of the body and the process of continuously evaluating their relative positions.

Paillard and Brouchon (1968) stated that kinesthesis and position sense may be served by the so-called "motor-outflow". They postulate the idea that some afferent control signal goes not only to the muscular organ but also has a corollary discharge, internally derived, to some comparator or correlator structure inside the central nervous system. Proprioception is seen by Paillard and Brouchon as necessary to (1) account for adjustments of motor commands to overcome changing conditions in the execution of movement and (2) to build spatial standards necessary in the first weeks or years of life. Taub and Berman's (1968) study deals in more detail with this structure and supports the concept of simultaneous internal neuronal response to afferent stimuli.

Roach (1966) proposed that initial information encoded by these afferent processes was analogous to a burst of electrical energy in the projection areas of the cortex without form, shape, figure-ground relationship, direction or spatial orientation. Through sequences of learning stages in which the child manipulates objects manually or motorically the perceptual data are matched to motor data so that perceptual data and motor information come to mean the same thing.

Perceptual-motor matching is essential according to Kephart (Roach and Kephart, 1966). If it is restricted the child is constantly confused by the two types of activity and the differing pictures of the outside world which they present to him. New learning must be based on the information already present, and since motor information represents the initial system, matching should occur in the direction of perceptual to motor.

Kephart's perceptual-motor theory was largely derived from research findings reported by such sources as Sherrington, Gesell, Piaget, Hebb and Strauss. Perceptual-motor theory holds that when the perceptual information has been organized so that consistent information concerning outside objects becomes available to the child the term perceptual learning as it is discussed by Strauss and others is possible. Perceptual learning can be said to depend upon prior motor learning as a foundation (Roach and Kephart, 1966).

Perceptual-motor theory is supported by data derived from investigation of physiological development. Embryonically the first system to develop neurologically is the motor system. The motor system is the initial system in both pre and post natal developmental hierarchy. Cephalo-caudal and proximo-distal principles refer to the facts that growth and motor

development proceed from the head end to the tail and from the axis to the periphery of the body (Chaney, 1968).

Taub and Berman's (1968) study of conditioned motoric activity in animals with deafferented limbs and obscured vision raises the interesting assumption that the perceptual motor system involves more than a single central-peripheral pathway for feedback information. Based on demonstrations by several investigators and on their own results, Taub and Berman postulated the existence of a "purely central feedback system" which could in effect return information concerning future movements to the CNS before the impulses that will produce these movements have reached the peripheral limb.

The significance of the postulation of a central mechanism is the implication that neural traces of "engrams" can be established on the basis of proximo-distal impulses within the CNS without requiring the return of the resulting motor activity to "stamp them in." To reduce the proposal to its simplest terms "the neurons of a motor center do not have to be told that they have fired, they know" (Taub and Berman, 1968).

The concept of a motor engram may be defined within the physiological frame of reference as a structural change in the nervous system effected by an experience and is considered by many to be the physical basis of memory. Physiological evidence described in Evarts' (1967) study of information processing supports the engram feed back system. Evarts delivered a stimulus to a monkey trained to make a very rapid movement in response - a response as rapid as a highly trained and motivated man could perform. He measured the axonal conduction velocity of the pyramidal tract neurons at the time of stimulation. He reported a temporal lapse of 100 milliseconds from the arrival of the stimulus until the volleys begin leaving

the motor cortex. The lapse is not anatomically inherent in the system as shown by Wall et al. who found that under chloralose anesthesia, volleys descend in the pyramidal tract 30 msec after the occurrence of a flash of light to which the animal has never been conditioned at all. Thus there exists an anatomical pathway which could save 70 msec minimum latency in pyramidal tract neuron response. Evarts' view is that the waking and normally functioning brain seems to hold and delay input information...but under chloralose anesthesia the delay imposed by this holding mechanism has disappeared. He cites the riddle of what happens in the 70 msec delay as one of the major challenges now facing the neuro-physiologist.

Biochemical evidence demonstrates chemical changes occurring in all afferent-efferent activation. The "bound" form of acetylcholine present in the brain is released by afferent nerve stimulation and is rapidly inactivated by cholinesterase which hydrolyzes the molecules to acetate and choline (Tower, 1958). From studies of cholinesterase inhibitors and acetylcholine blocking agents, Tower concludes that efferent activity is mediated by an acetylcholine receptor complex. He also proposed on the basis of differential distribution of acetylcholine and cholinesterase in dog brains, that not all central transmission was cholinergic in nature. He found the discrepancy between sensory and motor nerves and tracts of comparable physiologic activity to be great. Tower postulated a concept of interposed non-cholinergic links between excitory and inhibitory transmission systems.

Interdisciplinary studies are continuing to probe the riddle of the 70 msec interlude through neurological, biochemical and behavior studies. It is obvious that simplistic paradigms of computer brain networks which

sort through stored hypotheses add little to the search for an answer to the riddle.

For visually handicapped children the concept of motoric engrams refers to an essential learning modality for motor orientation and spatial perception. Chaney and Kephart (1968) describe four motor generalizations of significance in the education of visually handicapped children.

1. Balance and posture: Gravity is the one constant force in a constant direction. It must be established as a line of gravity through the observer's body in a direction noted by the observer. Then he can proceed to the development of coordinates of the space around him.

2. Contact: With contact skills the child investigates the relationships within objects. There are three aspects of contact activities: reach, grasp and release.

3. Locomotion: It is through locomotion activities that a child investigates the relationships between objects in space. Spatial directions and spatial orientations are developed through his own position then...in relation to the position of another object. All objects occupy a position on a spatial matrix with the three Euclidean coordinates as the principle axes.

4. Receipt and propulsion: Receipt relates to an object moving toward the child and propulsion involves activities with which the child relates to an object moving away from him.

The inter-relationships of motoric experiences, perceptual-motor skills and learning described by the investigations and theories cited, point up the urgent need for research to determine the effect of early

engramming of form and space concepts. Teuber (1967) reported a simple study which affirmed the effective differences on perceptual learning between active and passive motion. He cited Held and Hein's work at M.I.T. in which normal subjects were given prismatic spectacles which distorted visual orientation. Points in perceived space were displaced laterally and all straight lines seemed curved. The distortions disappeared if the spectacled subject was permitted to walk actively for one hour. If instead the subject was pushed about over the same path in a wheelchair for the same time, he did not adapt. The importance of establishing spatial orientation intrinsically through gross motor movements in early childhood is evident from the literature cited. Gross motor engramming is a learning modality through which a child interacts with the total environment. The visually handicapped child urgently needs motoric environmental interaction as a readiness base for mobility. All very young children need gross motoric engrams as foundations for spatial-perceptual development.

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